GEOTECHNICAL ENGINEERING REPORT
UTAH MUSEUM OF NATURAL HISTORY
SOUTH OF RED BUTTE GARDENS
SALT LAKE CITY, UTAH

PSI PROJECT No: 710-55135

November 28, 2005

Prepared For:
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1.0 INTRODUCTION

This report presents the results of a geotechnical investigation for a proposed Utah Museum of Natural History to be located in the eastern portion of the University of Utah Research Park in Salt Lake City, Utah. The services for this project were performed in accordance with PSI's Proposal No. 710-550098 dated September 14, 2005 and authorized by Mr. Lyle Knudsen dated October 14, 2005.

The purpose of this investigation was to explore subsurface materials and conditions at the site and develop recommendations for earthwork and design and construction of shallow foundations, and pavements. This report describes the work accomplished and presents our conclusions and recommendations for design and construction of the project.

2.0 BACKGROUND

The proposed project is located in the eastern portion of the University of Utah Research Park. As a part of initial planning, Utah Geologic and Mineral Survey provided an engineering geology report entitled *"Engineering Geology For Land-Use Planning For Research Park, University of Utah, Salt Lake City, Utah,"* dated 1986. A preliminary geotechnical report entitled "*Preliminary Geotechnical Report, Proposed Natural History Museum Building, University of Utah Campus-South of Red Butte Gardens and Arboretum*, dated November 2003 has prepared by Terracon, Inc.

3.0 PROJECT DESCRIPTION

Based on Conceptual Drawing prepared by Polshek Partnership Architects, PSI understands that the project will consist of constructing a new museum building along with terraced parking structures. The specific size and orientation of the structures were not finalized at the time this report was prepared; however, based on the concept plans, it appears that the proposed building may be a four-level structure with basement approximately 15 feet below final site grades. The building will likely be constructed with masonry walls, a steel joist roof system, and concrete floors. Based on our experience with similar projects, we have anticipate that the maximum column and continuous wall loads will be on the order of 500 kips and 15 kips/ft, respectively.

We also understand that a terraced parking structure is proposed for the southwest portion of the project site. The proposed parking structure will contain approximately 200 automobile parking stalls.

The geotechnical recommendations presented herein are based on the available project information, substation location, and the subsurface materials described in this report. If any of the noted information is different than described herein, please inform PSI in writing so that we may amend the recommendations presented in this report, where appropriate.

4.0 SITE DESCRIPTION

4.1 Site Conditions and Topography

The project site is situated adjacent to the western foothill slopes of the Wasatch Mountain Range. At the time of PSI's field investigation, the project site was a vacant parcel of land vegetated with weeds, various grasses, and small to medium shrubs. The Bonneville Shoreline recreation trail traverses the site from north to south, bisecting the eastern and western portions of the site. A buried pipeline utility considers follows the shoreline trail. Based on available topographic information, the ground surface at the project site generally slopes downward steeply to the south towards the Colorow Drive. The project site is currently bounded by Wasatch Mountain Range on the east, Red Butte Gardens on the north, Wakara Way on the west, and Colorow Drive on the south. Photo 1 depicts the site conditions and its surroundings at the time of our field investigation.

Photo 1. View of Proposed Site looking West-Southwest

4.2 Regional Geology

According to geologic maps of the area, the project site is mantled with Quaternary and recent unconsolidated sediments underlain by the Triassic Ankareh formation, the Triassic/Jurassic Nugget sandstone and the Jurassic Twin Creek Limestone. These sediments typically consist of clay, silt, and fine sand. A review of available liquefaction potential maps for Salt Lake County indicates that the project site is located in an area designated as "very low" in liquefaction potential. Based on review of available hazards maps, the project site is located less than ½ -mile east of the East Bench Fault. Based on a review of above-referenced Engineering Geology report, it appears that no active faults are located on or adjacent to the immediate project site. Earthquake design parameters including Site Class are provided in Section 8.9 of this report.

5.0 FIELD EXPLORATIONS

Subsurface conditions at the project site were evaluated using eleven (11) borings, designated B-1 through B-11, drilled at the approximate locations indicated on Figure A-2 in the Appendix. Seven (7) borings were drilled in the proposed building footprint area to depths ranging from about 30½ to 40 feet, three (3) borings were drilled in the proposed terraced parking structure area to depths ranging from about 11½ to 21 feet, and one (1) additional boring was drilled on the east side of the proposed terraced parking structure to depths of about 30 feet below existing site grades. The borings were drilled using a truck mounted drill rig equipped with both ODEX hammer and HQ wire-line coring equipment. The borings were located on the site by a member of our geotechnical staff by measuring approximate distances from known site landmarks. Drilling and sampling were performed under the direction of a PSI geotechnical engineer representative who maintained detailed logs of the subsurface materials and conditions encountered in the borings, and collected representative samples.

Samples were obtained at about 2½ to 5 foot intervals in each boring. Disturbed samples of the soils were obtained by driving a standard 2-inch (O.D.) split-spoon sampler into the soil a distance of 18 inches using a 140-lb hammer dropped from a height of 30 inches. The number of blows required to drive the sampler the last 12 inches is known as the standard penetration resistance, or N-value. The N-values provide a measure of the relative density of granular soils, such as sand, and the relative consistency, or stiffness, of cohesive soils, such as clay or silt. HQ-size rock core samples were obtained from the bedrock in 5-foot runs.

Collected soil samples were examined in the field and representative portions were stored in sealable plastic bags. The samples were transported to our laboratory for further examination and testing. Rock core samples were examined in the field transported to our laboratory in wax-coated core boxes. The borings were backfilled up to the ground surface with on-site soils.

6.0 LABORATORY TESTING

Representative samples of soil were tested to evaluate physical and engineering properties. The laboratory testing program included measurements of natural water content, determination, Atterberg limits, and grain size distribution. The results of the tests are presented on the Boring Logs, Figure A-3 through A-13 in the Appendix.

7.0 SUBSURFACE CONDITIONS

7.1 Soils

Borings generally encountered a soil profile containing approximately 18 to 30 inches of topsoil and underlain by layers of medium dense to dense silty sand with some Gravel (SM), loose to very dense poorly graded gravel with clay and sand with varying amounts of cobbles (GP-GC), medium dense to very dense clayey gravel with varying amounts of sand and cobbles and boulders (GC), medium dense to very dense silty gravel with sand (GM), medium dense poorly graded sand with silt and gravel (SP-SM), hard sandy lean clay to lean clay with sand (CL), and medium stiff silt with sand (ML). Bedrock was encountered in the borings at depths ranging from about 20 to 36½ feet below exiting site grades. The bedrock consists of highly fractured and weathered interbedded Conglomerate with Siltstone rock layers were encountered in the borings at depths ranging from about 20 to 36½ feet below existing site grades.

Standard Penetration resistance, N-Values, ranged from about six (6) blows per foot to greater than fifty (50) blows per foot for the native granular soils and about five (5) blows per foot to greater than fifty (50) blows per foot for native fine grained soils. Moisture contents of the selected soil samples tested in the laboratory ranged from about four (4) to twenty-one (21) percent. For a detailed description of the materials and conditions encountered at boring locations, please refer to Figures A-3 through A-13 in the Appendix.

The subsurface profile described above is a generalized interpretation provided to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for more specific information. These records include soil and rock description, stratifications, standard penetration resistances, location of samples, and laboratory test data. The stratifications shown on the borings logs represent the conditions only at the boring locations. The stratifications indicated on the boring logs represent the approximate boundary between subsurface materials. The actual transitions may be gradual. Subsurface materials and conditions may vary across relatively short distances at the site and may become apparent with additional explorations or excavation. If soil conditions are found to be different than described herein, we should be allowed to reevaluate our recommendations, where necessary.

7.2 Groundwater

Free water was encountered just above the bedrock in borings B-1, B-3, and B-7 at depths ranging from about twenty-nine (29) to thirty (30) feet below the existing ground surface during the field exploration. It should be noted that groundwater levels may fluctuate during the year depending on climatic and other factors. Additionally, discontinuous zones of perched water may exist at varying locations and depths beneath the ground surface. As a result, groundwater conditions during construction may be different than during the field investigation.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Geotechnical Discussion

The following geotechnical-related recommendations have been developed based on the subsurface conditions encountered in the borings and PSI's understanding of the proposed development. The primary geotechnical considerations with respect to the development include subgrade preparations and excavations, cut and fill slopes, foundation and pavement subgrade preparation, foundation subdrain, and surface drainage. Further details are provided in the following sections of the report.

8.2 Site Preparation and Earthwork

Topsoil, vegetation or other unsuitable material should be removed from beneath the proposed foundation areas. Excavation to depths ranging between about 12 to 30 inches will be required to remove organics, vegetation, topsoil, and other unsuitable material; however, greater or lesser amount of excavation may be required locally. Upon completion of the site stripping, the exposed subgrade should be evaluated by a representative of the Geotechnical Engineer.

Proof rolling with a loaded 10 yd^3 rubber-tired dump truck or similar construction equipment may be part of this evaluation. Any soft/loose areas identified should be over-excavated down to firm undisturbed soil or bedrock and backfilled with structural fill. On-site soils, exclusive of topsoil or other deleterious materials may be used as a structural fill provided they meet the requirements described in Section 8.4 of this report.

Please note that the near surface soils contain a significant percentage of fine-grained soils. These soils are sensitive to changes in moisture content. Typically, when these soils become wet they can become weak and unstable during construction activities. Construction traffic may induce rutting and disturbance from rubber-tired construction vehicles. Construction traffic should be limited to a temporary construction road surfaced with one (1) to two (2) feet of crushed gravel until the parking pavement section is constructed. Excavations should be conducted using an excavator equipped with a smooth edge and supported from outside the excavation. If the subgrade is disturbed during construction, soft, disturbed soils should be over-excavated to firm, undisturbed soil and backfilled with compacted granular materials. We recommend that site preparation, earthwork, and pavement subgrade preparation be accomplished during warmer, drier months, typically extending from mid-May to mid-October of the year.

8.3 Cut and Fill Slopes and Excavation Consideration

Typical construction practices and equipment may be employed in the upper 20 to 30 feet of the site with the significant exception of dense to very dense cemented sand and gravel encountered at the site that may require the use of heavy-duty equipment and possibly blasting to excavate to the desired subgrade elevations at the site. Excavation may be particularly difficult in confined, narrow excavations, such as utility trenches in localized areas.

Temporary construction excavations less than four (4) feet in height may be constructed with near-vertical side slopes. Deeper excavations less than ten (10) feet in depth should be constructed with side slopes no steeper than 1 horizontal to 1 vertical (1H:1V). OSHA regulations should be observed for all excavations. Temporary fill slopes constructed using on-site fill materials less than ten (10) feet in height should constructed 1H: 1V. If the desired unrestrained cut or fill slope requirements can not be met due to site constraints, temporary shoring systems may be considered. The design of temporary shoring systems is beyond our current scope of this work for this project. PSI would be pleased to futher discuss the scope of work that would be required to provide detailed recommendations to construct temporary shoring walls system to prevent slope failure during excavation. The excavation slopes that are not shored should be covered with plastic to reduce the effects of changes in moisture content (drying or wetting), which can reduce the stability of the excavation slope over time. PSI should visit the site and observe the actual materials and conditions in the excavation and modify recommendations if necessary.

Excavations should be performed with in accordance with OSHA regulations as stated in 29 CFR Part 1926. The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. PSI is providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations. The contractor should evaluate the soil exposed in the excavations as part of his/her safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

During periods of wet weather, earthen berms or other methods should be used to prevent runoff water from entering the excavations or slopes. The bottom of the excavations should be sloped to a collection point and discharged to a suitable location. Runoff water within the foundation and utility trench excavations should be collected and disposed of outside the construction limits.

8.4 Structural Fill

Structural fill should consist of well-graded sand or gravel material that is free of organic or other deleterious materials, have a maximum particle size of 3 inches, and contain less than 15 percent fines (material passing the No. 200 sieve). The portion of the fill finer than the No. 40 sieve should have a liquid limit less than 35 and a plasticity index less than 25. The structural fill should be moisture conditioned to optimum moisture to 3 percent over optimum, placed in lifts not exceeding 9 inches thick (loose) and compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557. Placement and compaction of structural fill should be observed, tested, and documented by a representative of the geotechnical engineer. Tested fill materials that do not achieve either the required dry density or moisture content requirements should be recorded, the location noted, and reported to the contractor and owner. A re-test of that area should be performed after the contractor performed all necessary remedial measures including moisture conditioning (wetting or drying) and reworking the fill. Please note that, select fill comprising of free-draining gravel having a maximum particle size of two (2) inches should be used where very moist or wet conditions are encountered.

Fill placed on sloping ground should be benched into existing slopes to provide a uniform horizontal placement. Benches should be at least 2 feet high. Special attention should be given to ensure that the moisture condition of the previous lift is within specification prior to placement of the next lift. Placement and compaction of structural fill should be observed, tested, and documented by a representative of the geotechnical engineer. Tested fill materials that do not achieve either the required dry density or moisture content requirements should be recorded, the location noted, and reported to the contractor and owner. These materials should then be removed or reworked and recompacted until the desired compaction is achieved. A re-test of that area should be performed after the contractor performed all necessary remedial measures.

8.5 Foundations

The proposed museum building can be supported on spread footings placed on undisturbed native soils or bedrock or on properly placed and compacted granular structural fill extending down to undisturbed native soils or bedrock. The contractor should understand that the on-site soils are sensitive to changes in moisture content and are easily disturbed and loosened by construction activities. Loose, soft, and/or otherwise disturbed soils are not suitable for supporting foundations and slabs and should be removed down to firm native soils or bedrock and replaced with properly placed and compacted structural fill. The following design parameters are recommended for footing design and construction:

- Foundations bearing on undisturbed native granular soils or on structural fill extending down to undisturbed native granular soils may be designed using an allowable bearing pressure of 3,500 psf. Footings established on bedrock may be designed using an allowable bearing pressure of 5,000 psf. The recommended allowable bearing pressure refers to the total dead load and can be increased by 1/3 to include the sum of all loads including wind and seismic.

- Footings should bear at a minimum depth of 30 inches below final grade for frost protection. For non-frost areas, such as interior footings, a minimum embedment depth of 18 inches is recommended.

- Foundations should have minimum lateral dimensions of 18 inches for continuous footings and 24 inches for isolated column footings.

- Structural fill, where required, should extend a minimum of ½ the depth of the fill laterally beyond the outside edge of the footing.

- PSI recommends that the foundations be designed in accordance with the IBC, 2003 edition.

We recommend that the footing excavations be observed and documented by PSI's geotechnical engineer or designated technical representative prior to placement of structural fill, concrete or reinforcing steel to verify their suitability for foundation support.

8.6 Foundation Settlements

Total settlement of an individual foundation will vary depending on the plan dimensions of the foundations and the actual load supported. For footings designed according to the recommendations described in Section 8.5 above, we estimate total settlement due to building loads under the static loading conditions will not exceed one (1) inch. Differential settlement is expected to approach about 50 to 75 percent of the total settlement under static conditions.

8.7 Floor Support

The proposed museum building, floor slabs can be supported either entirely on the native soil or on properly placed and compacted granular structural fill extending down to undisturbed native soil. We recommend that a minimum of 6 inches of free-draining gravel be placed immediately below the floor slabs and/or exterior flatwork to enhance drainage, promote curing, and aid in the distribution of floor loads. Installation of a vapor retarder beneath the floor should be considered if moisture sensitive floor coverings and contents are anticipated inside the building. The vapor retarder should be installed in accordance with the manufacturer's recommendations. The floor slab should have adequate number of joints to reduce cracking resulting from any differential movements and shrinkage.

8.8 Lateral Earth Pressures

Lateral earth pressures for the design of retaining or embedded walls depend on the type of construction, i.e., the ability of the wall to yield. Based on the type of proposed construction, we anticipate that possible lateral loading conditions may include: 1) subgrade walls such as basement walls are laterally supported at the base and top and therefore are not designed to yield; and 2) conventional cantilevered retaining walls which are designed to yield by tilting about the base.

- **Static Conditions**

  Non-yielding walls, i.e., walls that are supported at the top and bottom, can be designed using a at-rest lateral earth pressure based on an equivalent fluid having a unit weight of 55 pcf for horizontal backfill and 75 pcf for backfill that slopes upward at 2H:1V (26.7°). Walls that are allowed to yield can be designed based on an active equivalent fluid pressure of 35 pcf for horizontal backfill and 50 pcf for backfill that slopes upward at up to 2H:1V (26.7°). These recommended lateral earth pressure values assume that the backfill surface is fully drained so that hydrostatic pressure is not allowed to develop behind the wall. Additional static lateral pressures due to surcharge loadings in the backfill area can be estimated using the guidelines provided on Figure A-14 in the Appendix.

  Horizontal shear forces can be resisted partially or completely by frictional forces developed between the base of spread footings and the underlying soil. The total frictional resistance between the footing and the soil is the sum of vertical forces (dead load) times the coefficient of friction between the soil and the base of the footing. We recommend a value of 0.35 for the coefficient of friction for concrete placed on the native soils, or granular structural fill. If additional lateral resistance is required, passive soil resistance from embedded retaining walls and/or foundations bearing on undisturbed native soil may be evaluated on the basis of an equivalent fluid having a unit weight of 200 pcf.

- **Dynamic Conditions**

  For dynamic conditions, at-rest earth pressure for non-yielding walls can be estimated using the procedure presented by Wood (1973). Based on Wood (1973), the resultant of at-rest seismic force should be located 0.63H above the base of the wall; however, the use of 0.6H is deemed appropriate and the pressure distribution behind the wall is of inverted triangular shape. Non-yielding walls, i.e., walls that are supported at the top and bottom, can be designed based on a seismic at-rest seismic component of 60 pcf. Hence, for the seismic design for non-yielding walls, this component should be included in addition to the static equivalent at-rest earth pressure value.

  Mononobe-Okabe (M-O) pseudo-static theory of earth pressure for seismic forces is applicable for retaining walls that are capable of rotation and fully develop an active condition. This theory allows an equivalent fluid density to be used in design of retaining walls. This theory is based on the assumptions that

- The pressure distribution behind the retaining wall is of inverted triangular in shape as compared to static equivalent pressure distribution. When the static and dynamic pressures are combined, the equivalent pressure distribution will be approximately trapezoidal in shape with the resultant acting at 0.6H from the base of the wall,

- Soil behind the wall behaves as a rigid body, i.e, the acceleration is constant throughout the possible failure wedge.

- The wall yields to a degree sufficient so as to produce minimum active stress conditions, i.e., the wall is flexible.

- At minimum active pressure, soil wedge behind the wall is at incipient failure and the maximum shear strength is mobilized along the potential sliding surface.

Walls that are allowed to yield can be designed based on an active seismic component of 30 pcf. Hence, for seismic design of retaining walls, this component should be included in addition to the static equivalent active earth pressure value.

The M-O method of analysis can also be used to estimate the reduction in passive resistance for seismic design of retaining walls. For seismic conditions, the pressure distribution is triangular shape with the resultant force acting at 0.33H from the base of the wall. Therefore, retaining walls can be designed based on an passive seismic component of 160 pcf. Hence, for seismic design for retaining, this component should be included as a reduction in the static passive resistance value.

Special care should be taken while compacting the backfill behind below grade and/or retaining walls. Overcompaction of backfill behind retaining walls may result in the buildup of excessive lateral pressures, and potential structural distress. To avoid overcompaction of the backfill behind walls, we recommend that the backfill be compacted to 92% of the maximum dry density as determined by ASTM D1557. Heavy compactors and large pieces of construction equipment should not operate within 5 feet of the embedded wall to avoid the buildup of excessive lateral pressures unless the walls have been designed to accommodate these pressures. Compaction close to the walls may need to be accomplished using hand-operated compaction equipment.

8.9 Earthquake and Seismic Design Parameters

A review of seismic literature indicates that the project site is located less than ½ mile east of the East Bench Fault; however, no active faults pass through the project site. A search of the U.S. Geological Survey National Earthquake Hazard Reduction Program (NEHERP) database resulted in the following probabilistic ground motion values at the bedrock elevation for the project site located at 40.76 degrees North Latitude and 111.82 degrees West Longitude.

Exceedance Probability	2% in 50 Years
Peak Ground Acceleration (PGA)	0.61g
0.2 Sec Spectral Acceleration (S_S)	1.47g
1.0 Sec Spectral Acceleration (S_1)	0.57g

The 2003 Edition International Building Code (IBC) requires the assignment of a site class for the calculations of earthquake design forces. Site class is a function of soil profile i.e., depth of soil and strata type. Based on subsurface conditions encountered in our limited borings, the soil profile at the project site may be best characterized as Site Class C. Accordingly, site coefficient values F_a = 1.0 and F_v = 1.3 can be used for short and long period seismic design of structures.

8.9.1 Liquefaction Potential

Based on available liquefaction potential maps, the project site is located in an area designated as "very low" in liquefaction potential. In general, liquefaction is a condition where soils lose intergranular strength due to abrupt increases in pore water pressure. Pore water pressure increases typically occur during dynamic loading such as ground shaking during a seismic event. Liquefaction, should it occur on a site, can induce ground settlement and lateral spreading, which can result in damage to the structures. For liquefaction to occur, the following conditions must be present:

- The soil sediments must be in saturated or near-saturated conditions. At least 80-85 percent saturation is generally considered necessary for the liquefaction to occur.
- The soil must be predominately composed of non-plastic material such as sand or silt.
- The soil must be in a loose state.
- The soil must be subjected to dynamic loading, such as an earthquake.

Based on subsurface conditions encountered in the borings, granular soils are encountered in the borings are generally dense. With predominately gravel and cobbles encountered in the borings, the potential for increase in pore water pressure during a seismic event is low. Based on above criteria and subsurface conditions encountered, near-surface soils do not appear susceptible to liquefaction to depths of about upper 40 feet.

8.10 Utility Trench

Utility trenches should be kept free from water during excavation, fine grading, pipe laying, jointing, and embedment operations. Where the trench bottom is disturbed or otherwise unstable because of the presence of groundwater, or where the static groundwater elevation is above the bottom of the trench, groundwater should be lowered to the extent necessary using a suitable dewatering system to keep the trench free from water and the trench bottom stable when the work within the trench is in progress. Surface water should be prevented from entering trenches.

If unstable soils are encountered at invert elevations, it may be necessary to over-excavate and replace the unstable soils with free draining gravel backfill. The depth of over-excavation, if necessary, should be determined by field observation.

8.11.1 Utility Trench Backfill

The backfill placed in utility trench excavations within the limits of the building and paved areas should consist of sand, sand and gravel, or crushed rock with a maximum size of up to 1½ inches, and with not more that 5 percent passing the No. 200 sieve (washed analysis). This backfill should be uniformly moisture conditioned and firmly compacted for pipe support. Granular backfill should be placed in maximum 9 inches-thick lifts (loose) and compacted using vibratory compaction equipment or tamping units to at least 95 percent of the maximum dry density as determined by ASTM D 1557. Flooding or jetting the backfilled trenches with water to attempt to achieve compaction should not be permitted.

Even when placed and compacted under optimum conditions, trench backfill may settle over time. Therefore, all improvements such as floor slabs, footings, and pavements placed over trench backfill should be designed to span over localized irregularities or be designed to allow some differential movement.

8.12 Foundation Subdrain

We anticipate that excavation depths of about 15 to 20 feet will be required to construct the foundations for the proposed museum building. Due to perched water groundwater conditions encountered in borings B-1, B-3 and B-7, we recommend that a permanent subdrain system be designed and installed beneath the slab-on-grade floor of the proposed building. The subdrain system should be designed by a qualified engineer. Typical subdrain system detail is shown on Figure A-15 in the Appendix. The figure shows peripheral subdrains to drain any embedded wall which is drained by a system of subslab drainage pipes. All groundwater collected should be drained by gravity to a suitable discharge point.

8.13 Surface Drainage

Positive site drainage away from the proposed building should be established during the construction and maintained throughout the life of proposed building. Water should not be allowed to collect near the foundations or floor slab areas of the building or in pavement areas either during or after construction. Undercut or excavated areas should be sloped towards one corner to facilitate removal of any collected rainwater, groundwater seepage, or surface runoff. Water from roof downspouts should be conveyed in pipes that discharge in areas a safe distance away from the building. PSI recommends that a minimum 5 percent gradient should be maintained for a distance of at least 10 feet away from any foundation wall in unpaved areas.

8.14 Pavement

PSI anticipates that flexible pavement will be used for the new parking and drive areas. PSI has prepared a pavement design section based on soil characteristics similar to those encountered in the borings drilled at the site and relatively light traffic loads. For design purposes, PSI has based our pavement design on subgrade conditions consisting of unyielding, non-organic native soils or structural/granular fill. PSI has assumed light and heavy traffic consisting of about

4,000 and 5,000 Equivalent Single Axle Loads (ESALs), respectively to characterize the design pavement traffic over a 20-year design period at 80% reliability, California Bearing Ratio (CBR) value of 10, and initial and terminal serviceability of 4.2 and 2.0, respectively. Based on above design criteria, we recommend the following pavement sections should be used in pavement areas:

Pavement Materials	Recommended Pavement Thickness (inches)	
	Light Duty Section	Heavy Duty Section
Asphaltic Concrete	3	3
Granular Base course	6	8

Pavement materials and workmanship should conform the Utah Department of Transportation (UDOT) Standard Specifications for Road and Bridge Construction.

We understand rigid concrete pavement may be used in the approach apron areas and areas where trash dumpsters are to be parked on the pavement or where a considerable load is transferred from relatively small steel wheels. This should provide better distribution of surface loads to subgrade without causing deformation of the surface. PSI recommends that concrete pavement be designed for a modulus of subgrade reaction of 150 pci. The typical pavement section would be:

Pavement Materials	Recommended Pavement Thickness (inches)	
	Light Duty Section	Heavy Duty Section
Concrete (4,000 psi)	5	5
Granular Subbase	-	6

Please note that pavement subgrade should be proof rolled prior to placement of Granular Base course. Details regarding subgrade preparation and other details are provided in Section 8.2 of this report. PSI recommends that contingency be made for subgrade proof rolling, and over-excavation in some areas.

8.14.1 Pavement Drainage and Maintenance

Pavement subgrade should be sloped to provide rapid surface drainage. Water allowed to pond on or adjacent to pavement areas could saturate the subgrade or pavement section and cause premature deterioration of pavements, and removal and replacement may be required. Considerations should be given to the use of interceptor drains to collect and remove water from the granular base to a suitable location. The interceptor drains could be incorporated with storm drain or other utility trenches located in the pavement areas to facilitate drainage. Periodic maintenance of the pavement should be anticipated. This should include sealing of cracks and joints and by maintaining proper surface drainage to avoid ponding of water on or near the pavement area.

9.0 DESIGN REVIEW AND CONSTRUCTION SERVICES

PSI should be retained to review all geotechnical related portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in our report. Additionally, it is our opinion that all construction operations dealing with earthwork and foundations should be observed by a PSI representative to observe compliance with the intent of our recommendations, design concepts, and the plans and specifications. PSI's construction services will allow for timely design changes if site conditions are encountered that are different from those described in this report. Please note that if PSI is not allowed the opportunity to review project plans and specifications or observe exposed subgrade soil conditions during construction, we cannot be responsible for the application of our recommendations to subsurface conditions that are different from those described in this report.

10.0 GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding sections constitute PSI's professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and referenced during this evaluation, and PSI's experience in working with these conditions.

11.0 LIMITATIONS

The recommendations submitted are based on the available subsurface information obtained by PSI, and information provided by Department of Facilities and Construction Management (DFCM) and their design consultants. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation and/or other recommendations are required. If PSI is not retained to perform these functions, PSI cannot be responsible for the impact of those conditions on the performance of the project. The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

The geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of DFCM and their design consultants for the specific application to the proposed Utah Museum of

Natural History to be located in the eastern portion of the University of Utah Research Park in Salt Lake City, Utah.

PSI is committed to providing quality services to its clients, commensurate with their wants, needs, and desires. We appreciate the opportunity to provide our services on this project. If you have questions pertaining to this project or if we may be of further assistance, please call the undersigned.

Respectfully Submitted,
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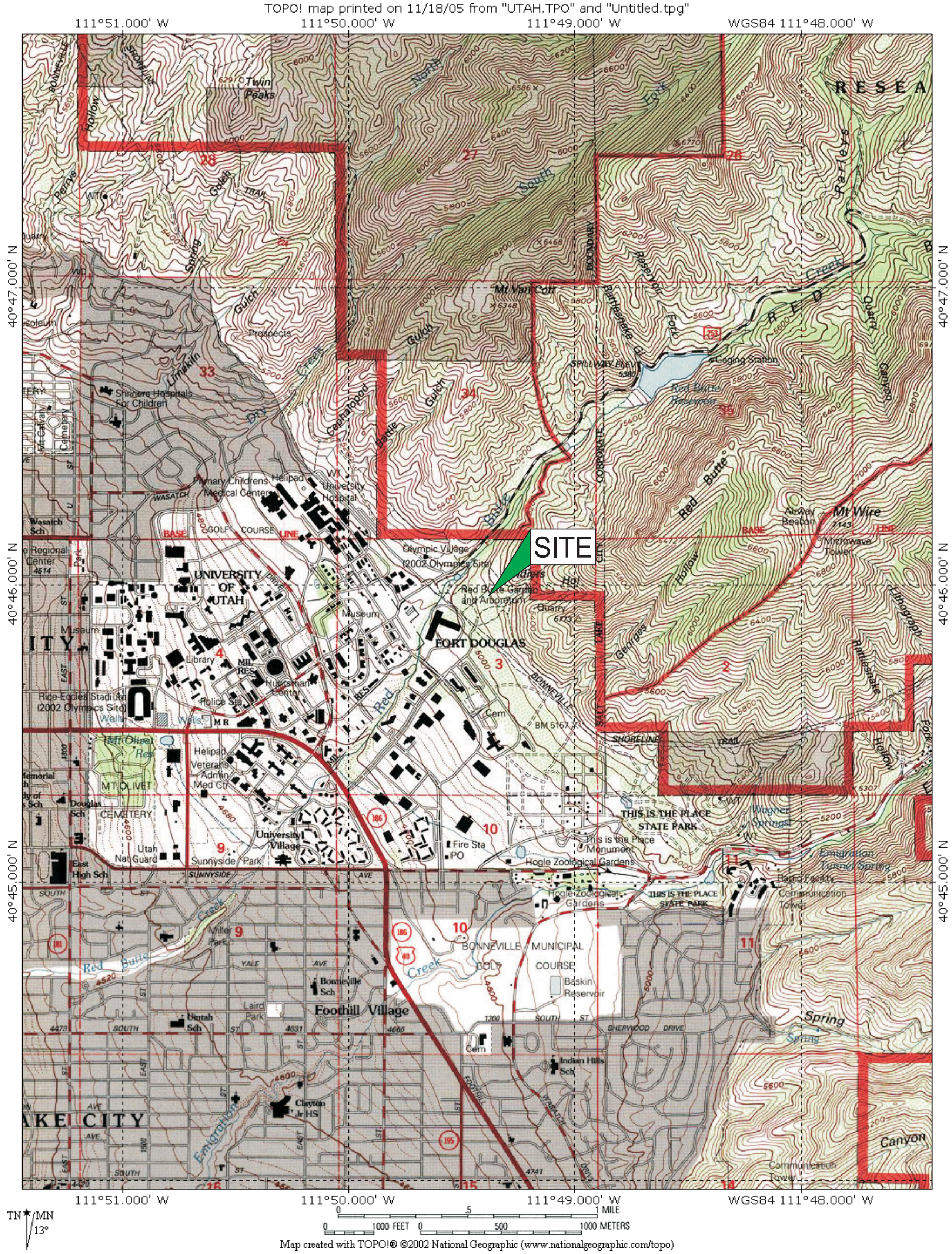
P:\Projects\710\Reports\2005 Reports\710-55135 Utah Museum of Natural History

APPENDIX

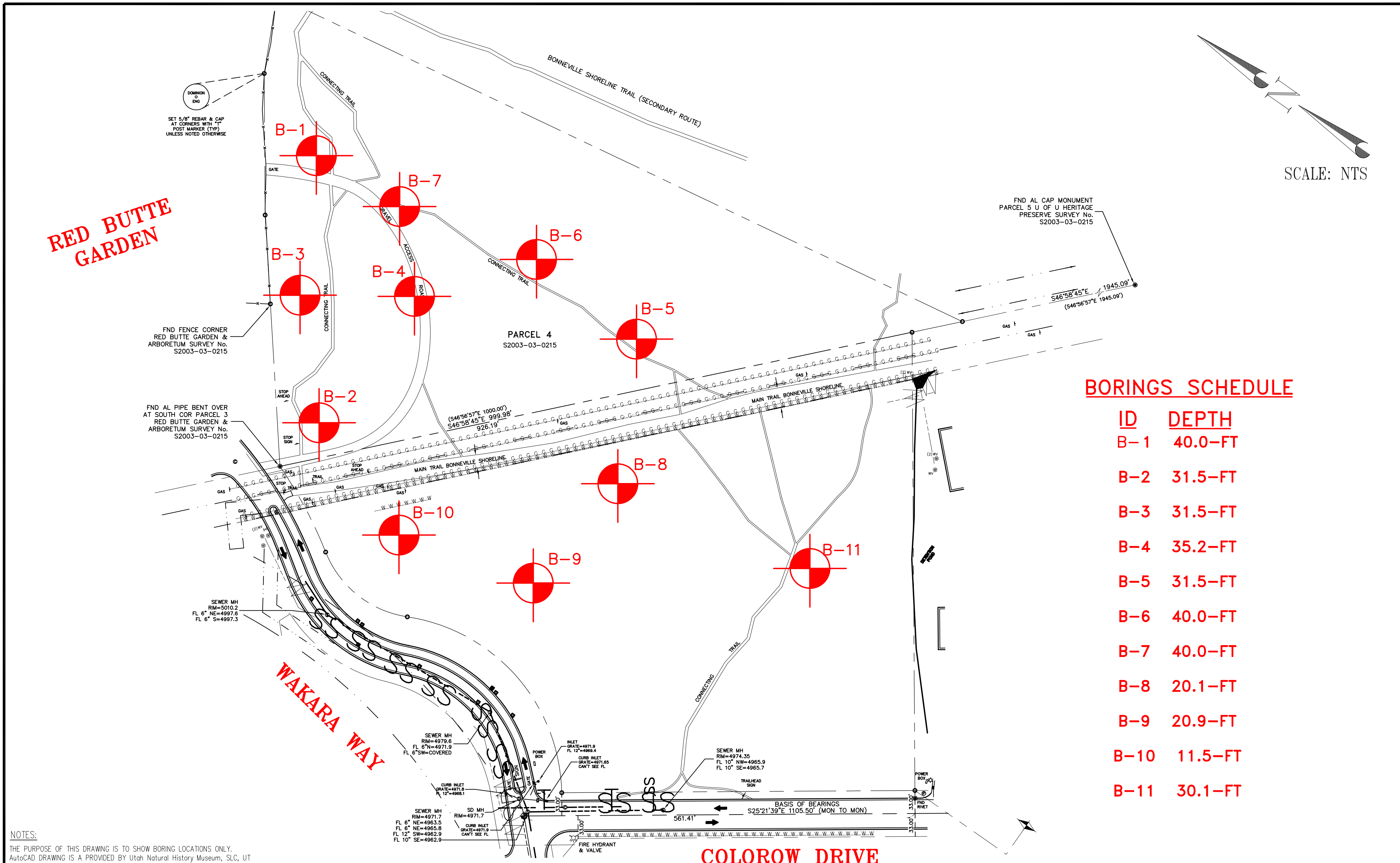
Vicinity Map
Site Plan With Boring Locations
Boring Logs
Surcharge Induced Lateral Earth Pressures
Perimeter Drain Detail

TOPO! map printed on 11/18/05 from "UTAH.TPO" and "Untitled.tpg"



Map created with TOPO!® ©2002 National Geographic (www.nationalgeographic.com/topo)

psi Information To Build On Engineering • Consulting • Testing	Project: Utah Museum of Natural History South of Red Butte Gardens Salt Lake City, Utah Project No: 710 - 55135	Drawn By: GPS Checked By: CTG Date: November, 2005	VICINITY MAP Scale: As Shown Figure: A-1



BORINGS SCHEDULE

ID	DEPTH
B-1	40.0-FT
B-2	31.5-FT
B-3	31.5-FT
B-4	35.2-FT
B-5	31.5-FT
B-6	40.0-FT
B-7	40.0-FT
B-8	20.1-FT
B-9	20.9-FT
B-10	11.5-FT
B-11	30.1-FT

NOTES:
THE PURPOSE OF THIS DRAWING IS TO SHOW BORING LOCATIONS ONLY.
AutoCAD DRAWING IS A PROVIDED BY Utah Natural History Museum, SLC, UT

FIGURE A-2

DRAWN BY: G.SINGH (PETE) | DATE: NOV., 05

CHECKED BY: CTG | Revisions:

SITE PLAN WITH APPROXIMATE BORING LOCATIONS

UTAH MUSEUM OF NATURAL HISTORY
SOUTH OF RED BUTTE GARDENS
SALT LAKE CITY, UTAH

PSI PROJECT NO. - 710-55135

psi Information To Build On
Engineering • Consulting • Testing
2779 South 600 West, Salt Lake City, UT-84115
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2779 South 600 West
Salt Lake City, UT 84115
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LOG OF BORING: B-1

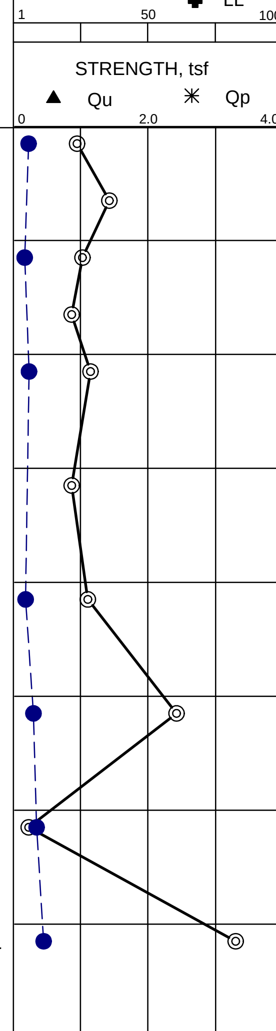
PSI Job No.:	710-55135	Drilling Method:	ODEX/CORING
Project:	Utah Museum of Natural History	Sampling Method:	2-in. O.D. Split-Spoon
Location:	South of Red Butte Gardens	Hammer Type:	Safety, 140-lb/30-in. drop
	Salt Lake City, Utah	Latitude:	40.765 N
		Longitude:	111.823 W

WATER LEVELS

While Drilling	29 ft
After Drilling	29 ft
After 24 hours	27 ft

Elevation, (feet)	Depth, (feet)	Sample Type	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0			Surface Elev.: ft ±				
		SS	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		7-12-12	6	
		SS	2	**Silty Sand:** -- dense, reddish-brown.		14-18-18		
	5	SS	3	-- medium dense.		14-13-13	4	Gradations; Granular = 76% Fines = 24%
		SS	4			9-10-12		
	10	SS	5			9-13-16	6	
					SM			
	15	SS	6			5-10-12		
	20	SS	7	-- with Gravel.		5-13-15	5	
	25	SS	8	**Poorly graded Gravel with Clay and Sand:** very dense, reddish-brown.		15-24-37	7	Gradations; Gravel=58% Sand = 33% Fines =10%
	30	SS	9	-- loose.	GP-GC	3-3-3	9	
	35	SS	10			6-40-43	11	
		RC	11	**Bedrock::** Interbedded Conglomerate with Siltstone layers, highly fractured, reddish-brown.				Recovery Length: Lr = 3-feet RQD = 8%
	40							
				Bottom of Boring @ 41.5-ft				

PENETRATION RESISTANCE blows/ft ◎ ● Moisture PL LL; STRENGTH, tsf ▲ Qu ✳ Qp



Completion Depth:	40.0 ft	Sample Types:	Remarks:
Date Drilling Started:	10/19/05	Auger Cutting (AC) / Shelby Tube (SH)	
Date Drilling Completed:	10/19/05	Split-Spoon (SS) / Grab Sample	
Logged By:	ST	Rock Core (RC) / Mod. California (MC)	
Driller:	EarthCore		

Figure A-3

2779 South 600 West
Salt Lake City, UT 84115
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Fax: (801) 487-3312

LOG OF BORING: B-2

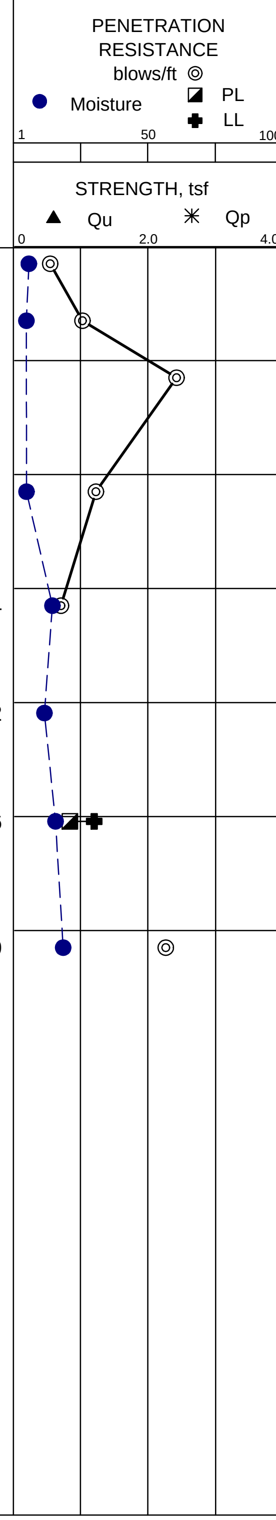
PSI Job No.:	710-55135	Drilling Method:	ODEX
Project:	Utah Museum of Natural History	Sampling Method:	2-in. O.D. Split-Spoon
Location:	South of Red Butte Gardens	Hammer Type:	Safety, 140-lb/30-in. drop
	Salt Lake City, Utah	Latitude:	40.765 N
		Longitude:	111.823 W

WATER LEVELS

While Drilling	NO GWT ft
After Drilling	NO GWT ft
After 24 hours	N/A

Surface Elev.: ft ±

Elevation, (feet)	Depth, (feet)	Sample Type	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0	SS	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		3-5-9	6	
		SS	2	**Silty Sand:** -- medium dense, reddish-brown.		9-11-15	5	
	5	SS	3	-- some Gravel, very dense.		24-27-34		
	10	SS	4	-- dense.	SM	10-13-18	5	
	15	SS	5	-- medium dense. -- probable cobbles/boulders at about 16-ft		11-9-9	14	Gradations; Granular = 66% Fines = 34%
	20	SS	6	**Clayey Gravel:** very dense, reddish-brown. -- cobbles/boulders at about 23-ft.		11-50/5"	12	
	25	SS	7	-- increasing cobbles and boulders.	GC	50/5"	16	Gradations; Granular = 61% Fines = 39% Atterberg Limits: Liquid Limit = 30% Plastic Limit = 21%
	30	SS	8	**Sandy Lean Clay:** some Gravel, hard, reddish brown to brown. Bottom of Boring @ 31.5-ft.	CL	15-17-40	19	Gradations; Granular = 41% Fines =59%



Completion Depth:	31.5 ft	Sample Types:	Remarks:
Date Drilling Started:	10/18/05	Auger Cutting (AC)	Shelby Tube (SH)
Date Drilling Completed:	10/18/05	Split-Spoon (SS)	Grab Sample
Logged By:	ST	Rock Core (RC)	Mod. California (MC)
Driller:	EarthCore		

Figure A-4

2779 South 600 West
Salt Lake City, UT 84115
PH: (801) 484-8827
Fax: (801) 487-3312

LOG OF BORING: B-3

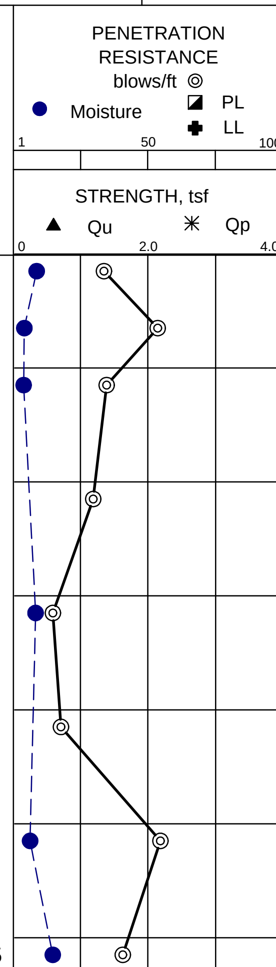
PSI Job No.:	710-55135
Project:	Utah Museum of Natural History
Location:	South of Red Butte Gardens Salt Lake City, Utah

Drilling Method:	ODEX
Sampling Method:	2-in. O.D. Split-Spoon
Hammer Type:	Safety, 140-lb/30-in. drop
Latitude:	40.765 N
Longitude:	111.823 W

WATER LEVELS	
While Drilling	30 ft
After Drilling	30 ft
After 24 hours	N/A

Surface Elev.: ft ±

Elevation, (feet)	Depth, (feet)	Sample Type	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0	SS	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		5-15-19	9	
		SS	2	**Silty Sand:** -- trace Gravel, dense, reddish-brown.	SM	20-28-26	4	Gradations; Granular = 74% Fines =26%
	5	SS	3		SM	14-13-22	4	
	10	SS	4		SM	13-14-16		
	15	SS	5	-- Becomes medium dense.	SM	5-7-8	8	Gradations; Granular =86% Fines = 14%
	20	SS	6		SM	8-8-10		
	25	SS	7	**Sandy Lean Clay:** hard, dark brown.	CL	19-20-35	6	
	30	SS	8		CL	10-13-28	15	
				Bottom of Boring @ 31.5-ft				



Completion Depth:	31.5 ft
Date Drilling Started:	10/17/05
Date Drilling Completed:	10/17/05
Logged By:	ST
Driller:	EarthCore

Sample Types:

- Auger Cutting (AC)
- Split-Spoon (SS)
- Rock Core (RC)
- Shelby Tube (SH)
- Grab Sample
- Mod. California (MC)

Remarks:

Figure A-5

2779 South 600 West
Salt Lake City, UT 84115
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Fax: (801) 487-3312

LOG OF BORING: B-4

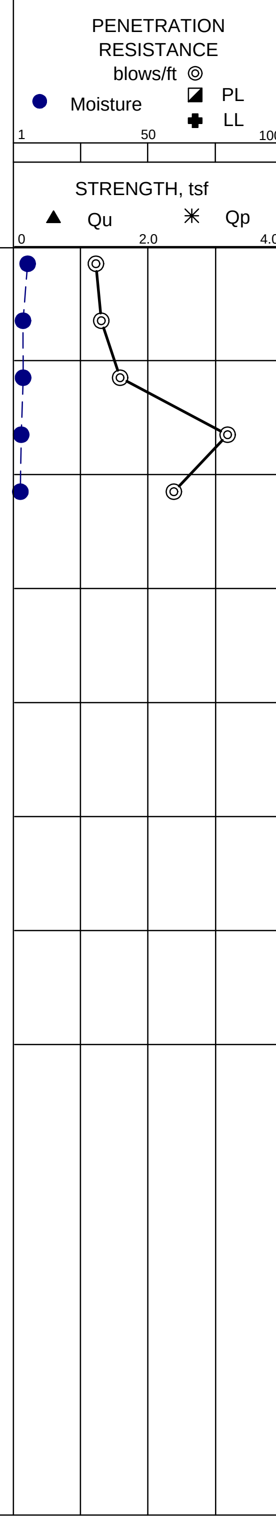
PSI Job No.: 710-55135
Project: Utah Museum of Natural History
Location: South of Red Butte Gardens, Salt Lake City, Utah

Drilling Method: ODEX
Sampling Method: 2-in. O.D. Split-Spoon
Hammer Type: Safety, 140-lb/30-in. drop
Latitude: 40.765 N
Longitude: 111.823 W

WATER LEVELS	
While Drilling	NO GWT ft
After Drilling	NO GWT ft
After 24 hours	N/A

Surface Elev.: ft ±

Elevation, (feet)	Depth, (feet)	Sample Type	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0	SS	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		8-15-16	5	
		SS	2	**Silty Sand:** some Gravel, dense, reddish-brown.	SM	8-15-18	4	
	5	SS	3			6-15-25	4	Gradations; Granular = 74% Fines =26%
		SS	4	-- Becomes very dense.		25-44-36	3	
	10	SS	5			11-26-34	3	Gradations; Granular = 79% Fines = 21%
	15	SS	6			50/1"		
				-- cobbles/boulders at about 17-ft				
	20		7	**Clayey Gravel with Sand:** with cobbles and boulders, very dense.	GC	50/0"		
	25	SS	8	**Bedrock:** Highly fractured Conglomerate with Siltstone layers.		50/2"		
	30	SS	9			50/1"		
	35	SS	10	Bottom of Boring @ 35.2-ft		50/2"		



Completion Depth: 35.2 ft
Date Drilling Started: 10/18/05
Date Drilling Completed: 10/18/05
Logged By: ST
Driller: EarthCore

Sample Types:
- Auger Cutting (AC)
- Split-Spoon (SS)
- Rock Core (RC)
- Shelby Tube (SH)
- Grab Sample
- Mod. California (MC)

Remarks:

2779 South 600 West
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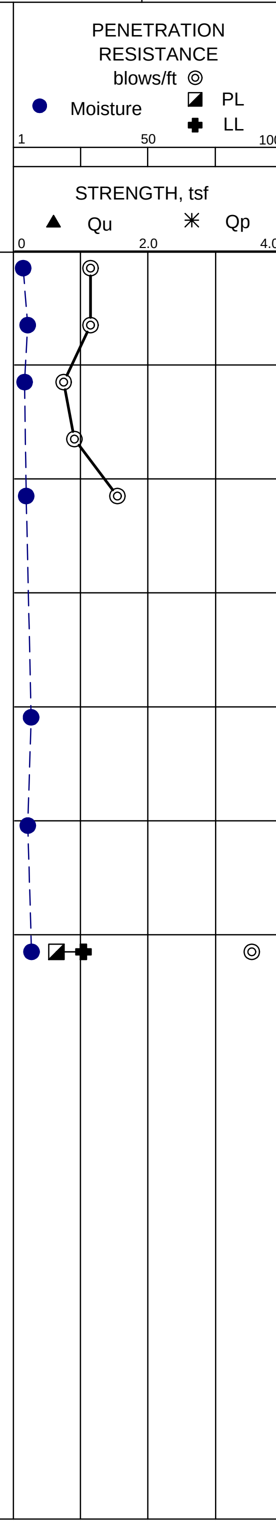
Fax: (801) 487-3312

LOG OF BORING: B-5

PSI Job No.:	710-55135	Drilling Method:	ODEX	WATER LEVELS	
Project:	Utah Museum of Natural History	Sampling Method:	2-in. O.D. Split-Spoon	While Drilling	NO GWT ft
Location:	South of Red Butte Gardens	Hammer Type:	Safety, 140-lb/30-in. drop	After Drilling	NO GWT ft
	Salt Lake City, Utah	Latitude:	40.765 N	After 24 hours	N/A
		Longitude:	111.823 W		

Surface Elev.: ft ±

Elevation, (feet)	Depth, (feet)	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		22-16-13	4	
		2	**Silty Sand:** -- medium dense.	SM	15-16-13	5	Gradations; Granular = 68% Fines =32%
	5	3			7-9-10	4	
		4			5-9-14		
	10	5	-- dense.		6-16-23	5	
	15	6	-- with Gravel, very dense.		50/5"		
			-- increasing Gravel, cobbles/boulders.				
	20	7	**Lean Clay with some Gravel:** hard, redish-brown.	CL	20-50/5"	7	Gradations; Granular = 19% Fines = 81%
	25	8	**Clayey Gravel with Sand:** very dense, reddish-brown.	GC	50/5"	5	
	30	9			28-39-50	7	Gradations; Granular = 52% Fines = 48% Atterberg Limits: Liquid Limit = 26% Plastic Limit = 16%
			Bottom of Boring @ 31.5-ft				



Completion Depth:	31.5 ft	Sample Types:		Remarks:
Date Drilling Started:	10/19/05	Auger Cutting (AC)	Shelby Tube (SH)	
Date Drilling Completed:	10/19/05	Split-Spoon (SS)	Grab Sample	
Logged By:	ST	Rock Core (RC)	Mod. California (MC)	
Driller:	EarthCore			

Figure A-7

2779 South 600 West
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LOG OF BORING: B-6

PSI Job No.:	710-55135
Project:	Utah Museum of Natural History
Location:	South of Red Butte Gardens Salt Lake City, Utah

Drilling Method:	ODEX/CORING
Sampling Method:	2-in. O.D. Split-Spoon
Hammer Type:	Safety, 140-lb/30-in. drop
Latitude:	40.765 N
Longitude:	111.823 W

WATER LEVELS	
While Drilling	NO GWT ft
After Drilling	NO GWT ft
After 24 hours	N/A

Surface Elev.: ft ±

Depth, (feet)	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
0	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		8-13-18	5	
	2	**Poorly graded Gravel with Clay and Sand:** -- very dense, reddish-brown.		20-38-39	2	
5	3	-- probable cobbles/boulders.		29-41-50/5"	2	
	4	-- increasing cobbles/boulders.		28-50/5"	2	
10	5		GP-GC	50/3"	3	Gradations; Gravel = 55% Sand = 33% Fines =12%
15	6			50/3"	2	
20	7	**Bedrock:** Highly fractured Conglomerate with Siltstone layers.		50/0"		
25	8			50/0"		
30	9			50/1"		
35	10			50/0"		Recovery Length: Lr = 2.5-feet RQD = 18%
	11					
40		Bottom of Boring @ 40-ft				

PENETRATION RESISTANCE blows/ft ◎ — Moisture ● — PL — LL (1, 50, 100)

STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)

Completion Depth:	40.0 ft
Date Drilling Started:	10/18/05
Date Drilling Completed:	10/18/05
Logged By:	ST
Driller:	EarthCore

Sample Types:
- Auger Cutting (AC)
- Split-Spoon (SS)
- Rock Core (RC)
- Shelby Tube (SH)
- Grab Sample
- Mod. California (MC)

Remarks:

Figure A-8

psi
2779 South 600 West
Salt Lake City, UT 84115
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Fax: (801) 487-3312

LOG OF BORING: B-7

PSI Job No.:	710-55135	Drilling Method:	ODEX/CORING
Project:	Utah Museum of Natural History	Sampling Method:	2-in. O.D. Split-Spoon
Location:	South of Red Butte Gardens	Hammer Type:	Safety, 140-lb/30-in. drop
	Salt Lake City, Utah	Latitude:	40.765 N
		Longitude:	111.823 W

WATER LEVELS

While Drilling	29 ft
After Drilling	29 ft
After 24 hours	N/A

Surface Elev.: ft ±

Elevation, (feet)	Depth, (feet)	Sample Type	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0	SS	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		16-17-18	5	
		SS	2	**Silty Gravel with Sand:**		30-50/5"		
	5	SS	3	-- very dense, reddish-brown.		50/2"		
		SS	4	-- cobbles/boulders.		33-27-50/3"	2	Gradations; Gravel = 50% Sand = 31% Fines = 19%
	10	SS	5		GM	42-50/3"		
				-- increasing cobbles/boulders at about 11-ft				
	15	SS	6	-- some fine Gravel, medium dense.		15-12-17	7	
	20	SS	7	**Bedrock:** Highly fractured Conglomerate with Siltstone layers.		18-50/3"	5	
	25	SS	8			50/1"		
	30	SS	9			36-50/3"	14	
	35	SS	10			18-32-17	21	
	40	RC	11					Recovery Length: Lr = 2-feet RQD = 0%
				Bottom of Boring @ 41.5-ft				

PENETRATION RESISTANCE blows/ft ◎ ● Moisture ◪ PL ✚ LL (1, 50, 100)

STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)

Completion Depth:	40.0 ft
Date Drilling Started:	10/20/05
Date Drilling Completed:	10/20/05
Logged By:	ST
Driller:	EarthCore

Sample Types:

- Auger Cutting (AC)
- Split-Spoon (SS)
- Rock Core (RC)
- Shelby Tube (SH)
- Grab Sample
- Mod. California (MC)

Remarks:

Figure A-9

2779 South 600 West
Salt Lake City, UT 84115
PH: (801) 484-8827
Fax: (801) 487-3312

LOG OF BORING: B-8

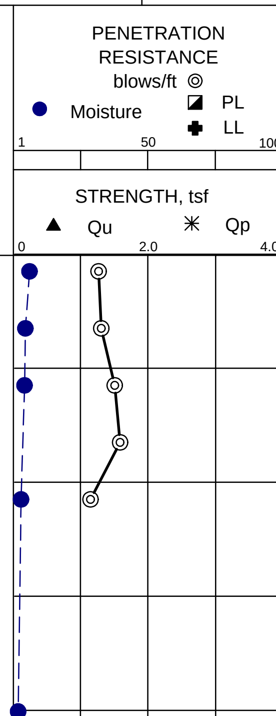
PSI Job No.:	710-55135	Drilling Method:	ODEX
Project:	Utah Museum of Natural History	Sampling Method:	2-in. O.D. Split-Spoon
Location:	South of Red Butte Gardens	Hammer Type:	Safety, 140-lb/30-in. drop
	Salt Lake City, Utah	Latitude:	40.765 N
		Longitude:	111.823 W

WATER LEVELS

While Drilling	NO GWT ft
After Drilling	NO GWT ft
After 24 hours	N/A

Surface Elev.: ft ±

Depth, (feet)	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
0	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		4-11-21	6	
	2	**Silt with Sand:** -- hard, reddish-brown.	ML	14-17-16	4	Gradations; Granular = 37% Fines = 63%
5	3			14-18-20	4	
	4			17-19-21		
10	5	**Poorly graded Gravel with Clay and Sand:** medium dense, reddish-brown. -- increasing Gravel. -- probable cobbles/boulders at about 14-ft.	GP-GC	7-14-15	3	Gradations; Granular =89% Fines = 11%
15	6	**Clayey Gravel:** some Sand, very dense, reddish-brown.	GC	50/3"		
20	7	**Bedrock:** Highly fractured Conglomerate with Siltstone layers. Bottom of Boring @ 20.1-ft		50/1"	2	



Completion Depth:	20.1 ft
Date Drilling Started:	10/19/05
Date Drilling Completed:	10/19/05
Logged By:	ST
Driller:	EarthCore

Sample Types:

- Auger Cutting (AC)
- Split-Spoon (SS)
- Rock Core (RC)
- Shelby Tube (SH)
- Grab Sample
- Mod. California (MC)

Remarks:

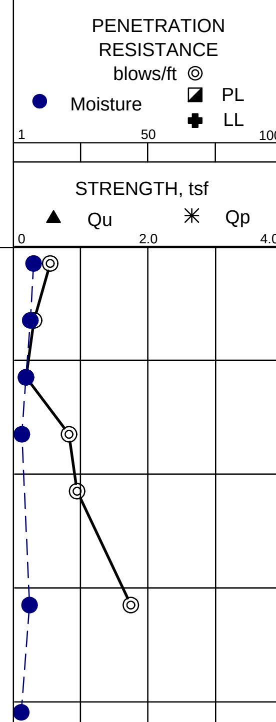
Figure A-10

2779 South 600 West
Salt Lake City, UT 84115
PH: (801) 484-8827
Fax: (801) 487-3312

LOG OF BORING: B-9

PSI Job No.:	710-55135	Drilling Method:	ODEX	WATER LEVELS	
Project:	Utah Museum of Natural History	Sampling Method:	2-in. O.D. Split-Spoon	While Drilling	NO GWT ft
Location:	South of Red Butte Gardens	Hammer Type:	Safety, 140-lb/30-in. drop	After Drilling	NO GWT ft
	Salt Lake City, Utah	Latitude:	40.765 N	After 24 hours	N/A
		Longitude:	111.823 W		

Elevation, (feet)	Depth, (feet)	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0		Surface Elev.: ft ±				
		1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		2-6-8	7	
		2	**Silt with Sand:** -- medium stiff, reddish-brown.	ML	7-5-3	6	Gradations; Granular = 38% Fines = 62%
	5	3			3-2-3	5	
		4	**Clayey Gravel:** medium dense, brown.		8-10-11	3	Gradations; Granular = 84% Fines =16%
	10	5			5-11-13		
	15	6	-- increasing Gravel. -- dense.	GC	13-18-26	6	Gradations; Granular = 79% Fines = 21%
			-- cobbles/boulders.				
	20	7	-- very dense.		18-50/5"	3	
			Bottom of Boring @ 20.92-ft				



Completion Depth:	20.9 ft	Sample Types:		Remarks:
Date Drilling Started:	10/19/05	Auger Cutting (AC)	Shelby Tube (SH)	
Date Drilling Completed:	10/19/05	Split-Spoon (SS)	Grab Sample	
Logged By:	ST	Rock Core (RC)	Mod. California (MC)	
Driller:	EarthCore			

Figure A-11

psi
2779 South 600 West
Salt Lake City, UT 84115
PH: (801) 484-8827
Fax: (801) 487-3312

LOG OF BORING: B-10

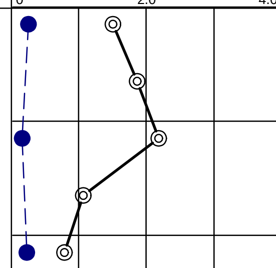
PSI Job No.:	710-55135
Project:	Utah Museum of Natural History
Location:	South of Red Butte Gardens Salt Lake City, Utah
Drilling Method:	ODEX
Sampling Method:	2-in. O.D. Split-Spoon
Hammer Type:	Safety, 140-lb/30-in. drop
Latitude:	40.765 N
Longitude:	111.823 W

WATER LEVELS	
While Drilling	NO GWT ft
After Drilling	NO GWT ft
After 24 hours	N/A

Elevation, (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0				Surface Elev.: ft ±				
			SS	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		3-16-22	6	
			SS	2	**Silty Sand:** -- dense, reddish-brown.	SM	14-25-22		
	5		SS	3	-- some Gravel, very dense.	SM	18-23-32	4	
			SS	4	-- medium dense.	SM	18-14-13		
	10		SS	5		SM	8-9-11	6	
					Bottom of Boring @ 11.5-ft				

PENETRATION RESISTANCE blows/ft ◎ ● Moisture ◪ PL ✚ LL (1 — 50 — 100)

STRENGTH, tsf ▲ Qu ✳ Qp (0 — 2.0 — 4.0)



Completion Depth:	11.5 ft
Date Drilling Started:	10/19/05
Date Drilling Completed:	10/19/05
Logged By:	ST
Driller:	EarthCore

Sample Types:
- Auger Cutting (AC)
- Split-Spoon (SS)
- Rock Core (RC)
- Shelby Tube (SH)
- Grab Sample
- Mod. California (MC)

Remarks:

psi
2779 South 600 West
Salt Lake City, UT 84115
PH: (801) 484-8827
Fax: (801) 487-3312

LOG OF BORING: B-11

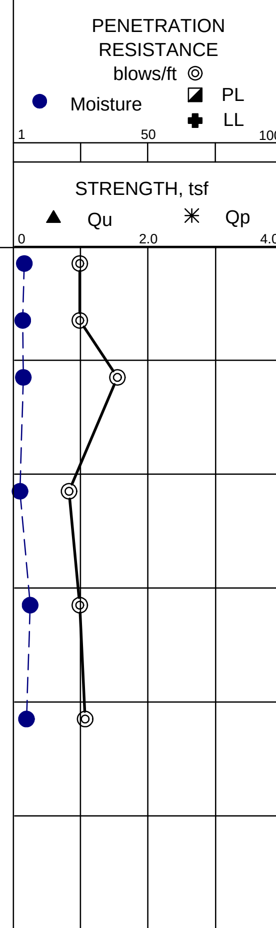
PSI Job No.:	710-55135
Project:	Utah Museum of Natural History
Location:	South of Red Butte Gardens Salt Lake City, Utah

Drilling Method:	ODEX
Sampling Method:	2-in. O.D. Split-Spoon
Hammer Type:	Safety, 140-lb/30-in. drop
Latitude:	40.765 N
Longitude:	111.823 W

WATER LEVELS	
While Drilling	NO GWT ft
After Drilling	NO GWT ft
After 24 hours	N/A

Surface Elev.: ft ±

Elevation, (feet)	Depth, (feet)	Sample No.	MATERIAL DESCRIPTION	USCS Classification	Penetration Resistance (per 6-inch)	Moisture, %	NOTES
	0	1	**TOPSOIL:** Silty Sand with some Gravel, vegetated, reddish-brown.		8-15-10	4	
		2	**Silty Sand:**	SM	10-11-14	3	
	5	3	-- medium dense, reddish-brown. -- dense.	SM	18-25-14	4	Gradations; Granular = 74% Fines = 26%
	10	5	-- some Gravel.	SM	10-11-10	2	
	15	6	**Poorly graded Sand with Silt and Gravel:** medium dense, reddish-brown.	SP-SM	9-11-14	6	Gradations; Granular = 89% Fines = 11%
	20	7		SP-SM	10-13-14	5	
	25	8	**Bedrock:** Highly fractured Conglomerate with Siltstone layers.		50/1"		
	30	9	Bottom of Boring @ 30.1-ft		50/1"		



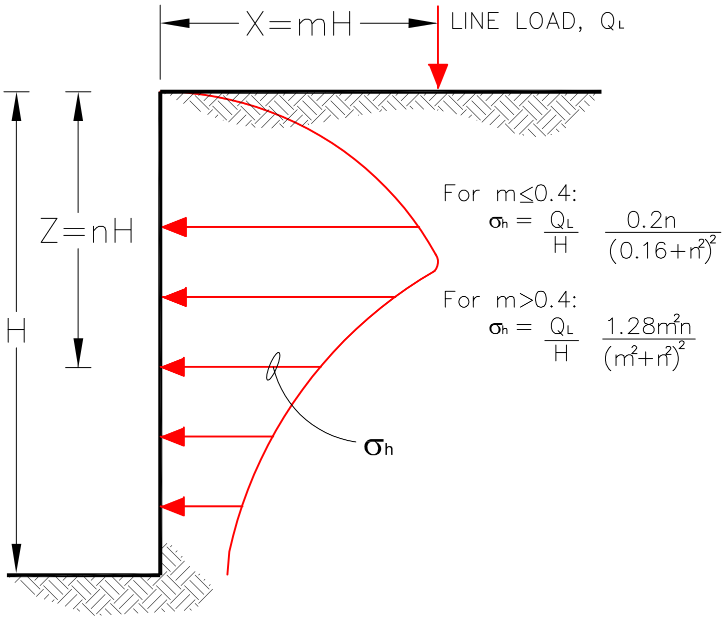
Completion Depth:	30.1 ft
Date Drilling Started:	10/19/05
Date Drilling Completed:	10/19/05
Logged By:	ST
Driller:	EarthCore

Sample Types:

- Auger Cutting (AC)
- Split-Spoon (SS)
- Rock Core (RC)
- Shelby Tube (SH)
- Grab Sample
- Mod. California (MC)

Remarks:

Figure A-13



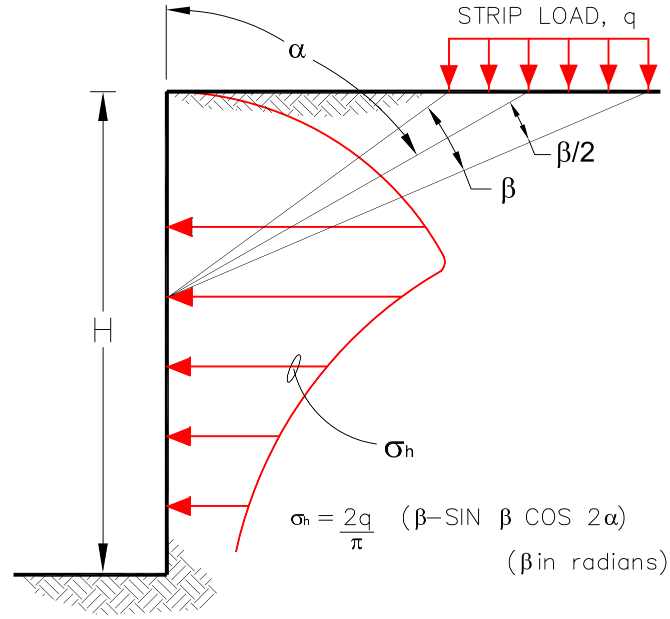
For m≤0.4:

$$\sigma_h = \frac{Q_L}{H}\,\frac{0.2n}{(0.16+n^2)^2}$$

For m>0.4:

$$\sigma_h = \frac{Q_L}{H}\,\frac{1.28m^2n}{(m^2+n^2)^2}$$

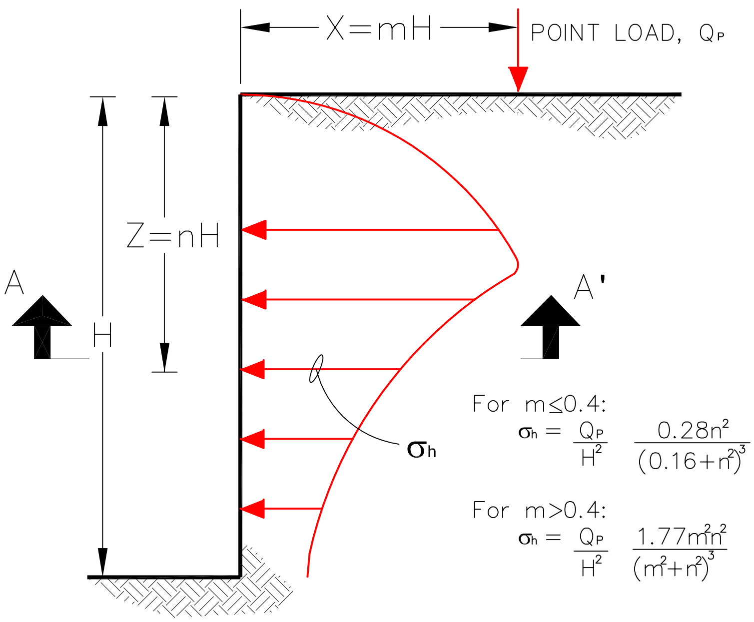
LINE LOAD PARALLEL TO WALL



$$\sigma_h = \frac{2q}{\pi}\,(\beta - \mathrm{SIN}\ \beta\ \mathrm{COS}\ 2\alpha)$$

(β in radians)

STRIP LOAD PARALLEL TO WALL

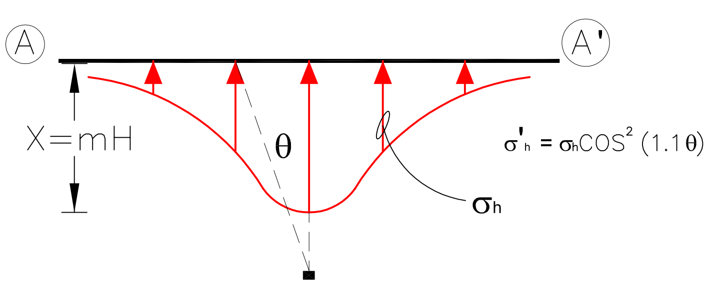


For m≤0.4:

$$\sigma_h = \frac{Q_P}{H^2}\,\frac{0.28n^2}{(0.16+n^2)^3}$$

For m>0.4:

$$\sigma_h = \frac{Q_P}{H^2}\,\frac{1.77m^2n^2}{(m^2+n^2)^3}$$



$$\sigma'_h = \sigma_h \mathrm{COS}^2\,(1.1\theta)$$

DISTRIBUTION OF HORIZONTAL PRESSURES

VERTICAL POINT LOAD

NOTES:

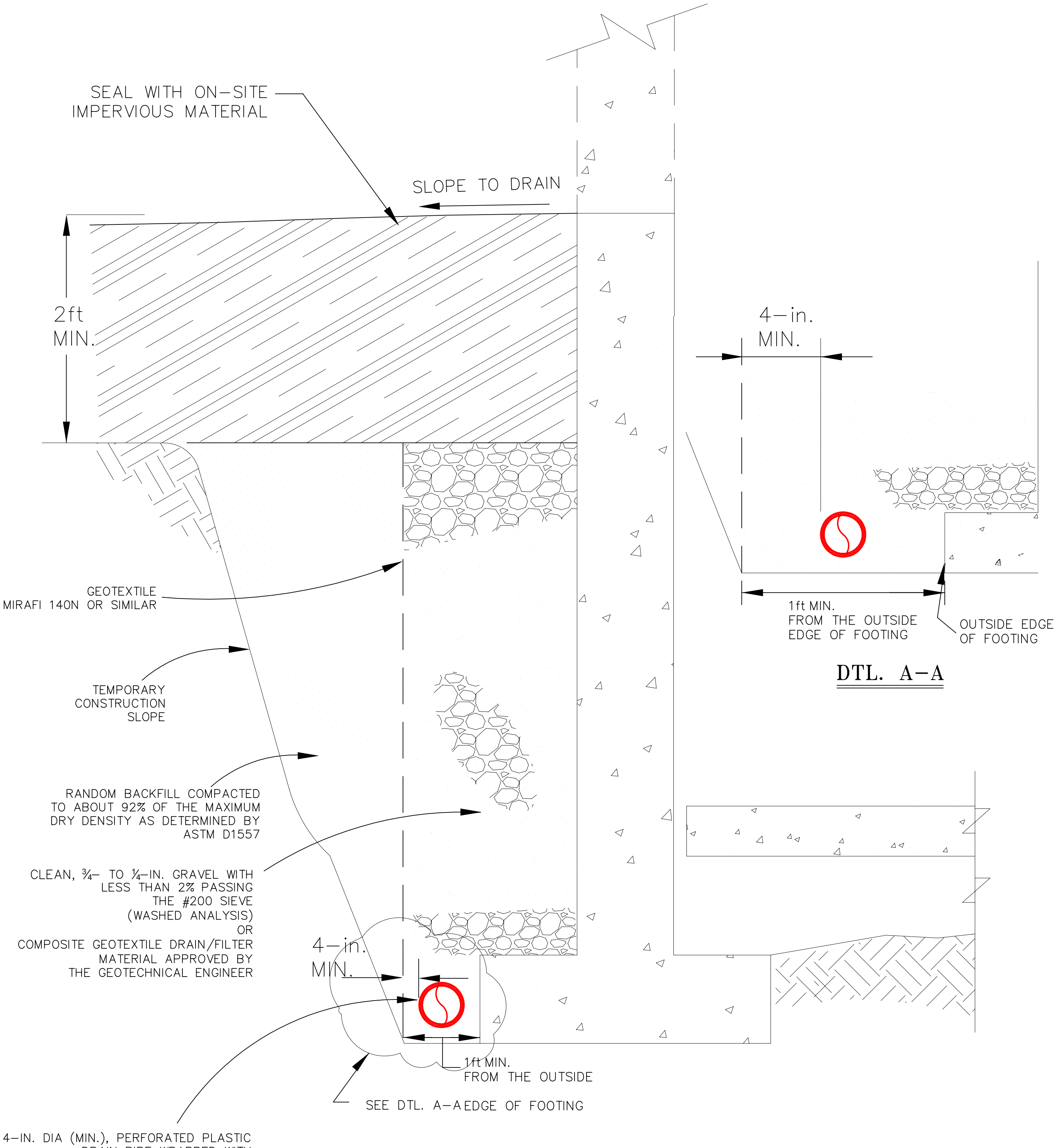
1. These guidelines apply to rigid walls with Poisson's ratio assumed to be 0.5 for backfill materials.

2. Lateral pressures from any combination of above loads may be determined by the principle of superposition.

FIGURE: A-14	SCALE: NTS	SURCHARGE INDUCED STATIC LATERAL EARTH PRESSURES
DRAWN BY: G.SINGH(PETE)		UTAH MUSEUM OF NATURAL HISTORY SOUTH OF RED BUTTE GARDENS SALT LAKE CITY, UT
CHECKED BY: REB		Project No: 710-55135

psi Information To Build On

Engineering • Consulting • Testing



PERIMETER DRAIN

FIGURE: A–15	SCALE: NTS	PERIMETER DRAIN UTAH MUSEUM OF NATURAL HISTORY SOUTH OF RED BUTTE GARDENS SALT LAKE CITY, UTAH Project No: 710–55135	psi Information To Build On Engineering • Consulting • Testing
DRAWN BY: G.SINGH(PETE)			
CHECKED BY: REB			